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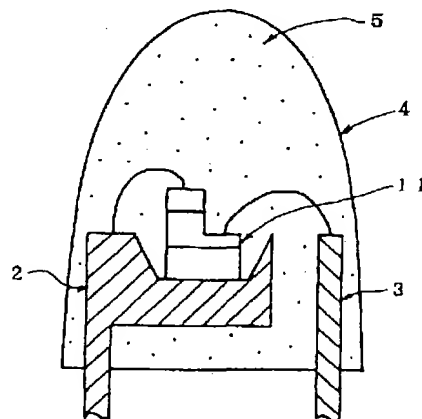
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(54)【発明の名称】 発光ダイオード

(57)【要約】

【目的】 発光ピークが430nm付近、および370nm付近にある窒化ガリウム系化合物半導体材料よりなる発光素子を有する発光ダイオードの視感度を良くし、またその輝度を向上させる。

【構成】 ステム上に発光素子を有し、それを樹脂モールドで包囲してなる発光ダイオードにおいて、前記発光素子が、一般式 $Ga_xAl_{1-x}N$  (但し $0 \leq x \leq 1$ である)で表される窒化ガリウム系化合物半導体よりなり、さらに前記樹脂モールド中に、前記窒化ガリウム系化合物半導体の発光により励起されて蛍光を発する蛍光染料、または蛍光顔料が添加されてなる発光ダイオード。



## LIGHT EMITTING DIODE

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Inventor(s): TADATSU YOSHIAKI; others: 01  
Applicant(s): NICHIA CHEM IND LTD  
Requested Patent: ☐ JP5152609  
Application Number: JP19910336011 19911125  
Priority Number(s):  
IPC Classification: H01L33/00  
EC Classification:  
Equivalents:

### Abstract

**PURPOSE:**To improve the visibility and brightness of a light emitting diode having a light emitting element made of a gallium nitride based compound semiconductor material having its light emitting peaks near 430nm and 370nm.

**CONSTITUTION:**In a light emitting diode comprising a light emitting elect 11 on a stem and a resin mold 4 surrounding it, the light emitting element 11 is made of a gallium nitride based compound semiconductor specified by a general chemical formula  $GaxAl_{1-x}N$  (where  $0 \leq x \leq 1$ ), and further, a fluorescent dye 5 or a fluorescent pigment, which emits a fluorescent light excited by the light emission of the gallium nitride based compound semiconductor, is added additionally in the resin mold 4.

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## 【特許請求の範囲】

【請求項1】 ステム上に発光素子を有し、それを樹脂モールドで包囲してなる発光ダイオードにおいて、前記発光素子が、一般式  $Ga_xAl_{1-x}N$  (但し  $0 \leq x \leq 1$  である) で表される窒化ガリウム系化合物半導体よりなり、さらに前記樹脂モールド中に、前記窒化ガリウム系化合物半導体の発光により励起されて蛍光を発する蛍光染料、または蛍光顔料が添加されてなることを特徴とする発光ダイオード。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】 本考案は発光素子を樹脂モールドで包囲してなる発光ダイオード（以下LEDという）に係り、特に一種類の発光素子で多種類の発光ができ、さらに高輝度な波長変換発光ダイオードに関する。

## 【0002】

【従来の技術】 一般に、LEDは図1に示すような構造を有している。1は1mm角以下に切断された例えばGaAlAs、GaP等よりなる発光素子、2はメタルステム、3はメタルポスト、4は発光素子を包囲する樹脂モールドである。発光素子1の裏面電極はメタルステム2に銀ペースト等で接着され電氣的に接続されており、発光素子1の表面電極は他端子であるメタルポスト3から伸ばされた金線によりその表面でワイヤボンドされ、さらに発光素子1は透明な樹脂モールド4でモールドされている。

【0003】 通常、樹脂モールド4は、発光素子の発光を空气中に効率よく放出する目的で、屈折率が高く、かつ透明度の高い樹脂が選択されるが、他に、その発光素子の発光色を変換する目的で、あるいは色を補正する目的で、その樹脂モールド4の中に着色剤として無機顔料、または有機顔料が混入される場合がある。例えば、GaPの半導体材料を有する緑色発光素子の樹脂モールド中に、赤色顔料を添加すれば発光色は白色とすることができる。

## 【0004】

【発明が解決しようとする課題】 しかしながら、従来、樹脂モールドに着色剤を添加して波長を変換するという技術はほとんど実用化されておらず、着色剤により色補正する技術がわずかに使われているのみである。なぜなら、樹脂モールドに、波長を変換できるほどの非発光物質である着色剤を添加すると、LEDそのものの自体の輝度が大きく低下してしまうからである。

【0005】 ところで、現在、LEDとして実用化されているのは、赤外、赤、黄色、緑色発光のLEDであり、青色または紫外のLEDは未だ実用化されていない。青色、紫外発光の発光素子はII-VI族のZnSe、I-V族のSiC、III-V族のGaN等の半導体材料を用いて研究が進められ、最近、その中でも一般式が  $Ga_xAl_{1-x}N$  (但し  $x$  は  $0 \leq x \leq 1$  である。) で表される窒

化ガリウム系化合物半導体が、常温で、比較的優れた発光を示すことが発表され注目されている。また、窒化ガリウム系化合物半導体を用いて、初めてpn接合を実現したLEDが発表されている（応用物理、60巻、2号、p163～p166、1991）。それによるとpn接合の窒化ガリウム系化合物半導体を有するLEDの発光波長は、主として430nm付近にあり、さらに370nm付近の紫外域にも発光ピークを有している。その波長は上記半導体材料の中で最も短い波長である。しかし、そのLEDは発光波長が示すように紫色に近い発光色を有しているため視感度が悪いという欠点がある。

【0006】 本発明はこのような事情を鑑みなされたもので、その目的とするところは、発光ピークが430nm付近、および370nm付近にある窒化ガリウム系化合物半導体材料よりなる発光素子を有するLEDの視感度を良くし、またその輝度を向上させることにある。

## 【0007】

【課題を解決するための手段】 本発明は、ステム上に発光素子を有し、それを樹脂モールドで包囲してなる発光ダイオードにおいて、前記発光素子が、一般式  $Ga_xAl_{1-x}N$  (但し  $0 \leq x \leq 1$  である) で表される窒化ガリウム系化合物半導体よりなり、さらに前記樹脂モールド中に、前記窒化ガリウム系化合物半導体の発光により励起されて蛍光を発する蛍光染料、または蛍光顔料が添加されてなることを特徴とするLEDである。

【0008】 図2は本発明のLEDの構造を示す一実施例である。11はサファイア基板の上にGaAlNがn型およびp型に積層されてなる青色発光素子、2および3は図1と同じくメタルステム、メタルポスト、4は発光素子を包囲する樹脂モールドである。発光素子11の裏面はサファイアの絶縁基板であり裏面から電極を取り出せないため、GaAlN層のn電極をメタルステム2と電氣的に接続するため、GaAlN層をエッチングしてn型層の表面を露出させてオーミック電極を付け、金線によって電氣的に接続する手法が取られている。また他の電極は図1と同様にメタルポスト3から伸ばした金線によりp型層の表面でワイヤボンドされている。さらに樹脂モールド4には420～440nm付近の波長によって励起されて480nmに発光ピークを有する波長を発光する蛍光染料5が添加されている。

## 【0009】

【発明の効果】 蛍光染料、蛍光顔料は、一般に短波長の光によって励起され、励起波長よりも長波長光を発光する。逆に長波長の光によって励起されて短波長の光を発光する蛍光顔料もあるが、それはエネルギー効率が非常に悪く微弱にしか発光しない。前記したように窒化ガリウム系化合物半導体はLEDに使用される半導体材料中で最も短波長側にその発光ピークを有するものであり、しかも紫外域にも発光ピークを有している。そのためそれを発光素子の材料として使用した場合、その発光素子

を包囲する樹脂モールドに蛍光染料、蛍光顔料を添加することにより、最も好適にそれら蛍光物質を励起することができる。したがって青色LEDの色補正はいうにおよばず、蛍光染料、蛍光顔料の種類によって数々の波長の光を変換することができる。さらに、短波長の光を長波長に変え、エネルギー効率がよい為、添加する蛍光染料、蛍光顔料が微量で済み、輝度の低下の点からも非常に好都合である。

\*【図面の簡単な説明】

【図1】 従来の一LEDの構造を示す模式断面図。

【図2】 本発明のLEDの一実施例の構造を示す模式断面図。

【符号の説明】

1・・・発光素子

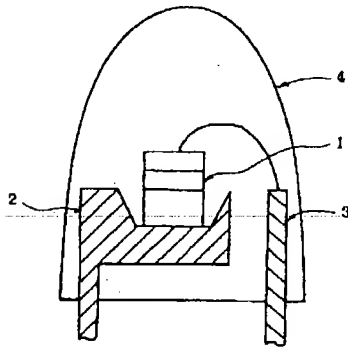
2・・・メタルステム

3・・・メタルポスト

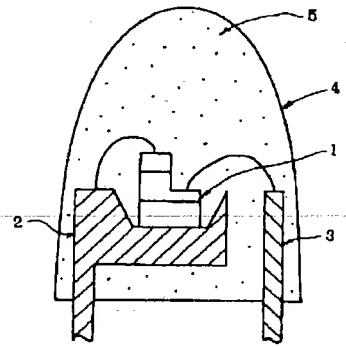
4・・・樹脂モールド

5・・・蛍光染料。

【図1】



【図2】



1/8

## PATENT ABSTRACTS OF JAPAN

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(21)Application number : 03-336011

(71)Applicant : NICHIA CHEM IND LTD

(22)Date of filing : 25.11.1991

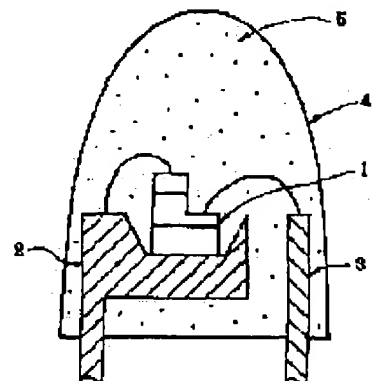
(72)Inventor : TADATSU YOSHIKI  
NAKAMURA SHUJI

## (54) LIGHT EMITTING DIODE

## (57)Abstract:

PURPOSE: To improve the visibility and brightness of a light emitting diode having a light emitting element made of a gallium nitride based compound semiconductor material having its light emitting peaks near 430nm and 370nm.

CONSTITUTION: In a light emitting diode comprising a light emitting elect 11 on a stem and a resin mold 4 surrounding it, the light emitting element 11 is made of a gallium nitride based compound semiconductor specified by a general chemical formula  $GaxAl_{1-x}N$  (where  $0 < x < 1$ ), and further, a fluorescent dye 5 or a fluorescent pigment, which emits a fluorescent light excited by the light emission of the gallium nitride based compound semiconductor, is added additionally in the resin mold 4.



## LEGAL STATUS

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[Date of sending the examiner's decision of rejection]	23.06.1998
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	withdrawal
[Date of final disposal for application]	02.12.1999
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	10-11520
[Date of requesting appeal against examiner's decision of rejection]	23.07.1998
[Date of extinction of right]	

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CLAIMS

[Claim(s)]

[Claim 1] Light emitting diode which it has a light emitting device on a stem, and the aforementioned light emitting device consists of a gallium-nitride system compound semiconductor expressed with general formula  $GaXAl^{1-X}N$  (however, it is  $0 \leq X \leq 1$ ), and the fluorescent dye which is further excited by luminescence of the aforementioned gallium-nitride system compound semiconductor in the aforementioned resin mould, and emits fluorescence, or a fluorescent pigment is added in the light emitting diode which comes to surround it by the resin mould, and is characterized by the bird clapper.

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## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] the light emitting diode (it is called Following Light Emitting Diode) to which this design comes to surround a light emitting device by the resin mould -- starting -- especially, one kind of light emitting device -- luminescence of varieties -- it can do -- further -- high -- it is related with brightness wavelength conversion light emitting diode

[0002]

[Description of the Prior Art] Generally, Light Emitting Diode has structure as shown in drawing 1. The light emitting device from which 1 was cut below at 1mm angle and which consists of GaAlAs, GaP, etc., for example, and 2 are resin moulds to which a metal stem and 3 surround a metal post and 4 surrounds a light emitting device. The rear-face electrode of a light emitting device 1 pastes the metal stem 2 with a silver paste etc., and is electrically connected to it, wire bond of the surface electrode of a light emitting device 1 is carried out on the front face by the gold streak lengthened from the metal post 3 which is an other end child, and the mould of the light emitting device 1 is further carried out by the transparent resin mould 4.

[0003] Usually, although the resin mould 4 is the purpose which emits luminescence of a light emitting device efficiently into air and a highly transparent resin is chosen highly [ a refractive index ], otherwise, it is the purpose which changes the luminescent color of the light emitting device, or is the amendment purpose about a color, and an inorganic pigment or an organic pigment may be mixed as a coloring agent into the resin mould 4. For example, the luminescent color can be made white if red pigments are added in the resin mould of the green light emitting device which has the semiconductor material of GaP.

[0004]

[Problem(s) to be Solved by the Invention] However, most technology of adding a coloring agent to a resin mould and changing wavelength is [ that the technology which it is not put in practical use but carries out a color correction with a coloring agent is only used slightly, and ] conventionally. It is because the brightness of the Light Emitting Diode [ itself ] itself will fall greatly if the coloring agent which is a non-photogene to the extent that wavelength is convertible for a resin mould is added.

[0005] By the way, infrared rays, red, yellow, and Light Emitting Diode of green luminescence are put in practical use as a Light Emitting Diode now, and blue or ultraviolet Light Emitting Diode is not yet put in practical use. Research is advanced using semiconductor materials, such as an II-VI group's ZnSe, an IV-IV group's SiC, and a III-V group's GaN, also in it, it is announced that the gallium-nitride system compound semiconductor to which a general formula is expressed with  $\text{GaXAl}_1\text{-XN}$  (however,  $X$  is  $0 \leq X \leq 1$ .) shows luminescence from which it is ordinary temperature and which was excelled comparatively, and blue and the light emitting device of ultraviolet luminescence attract attention recently. Moreover, Light Emitting Diode which realized pn junction for the first time is announced using the gallium-nitride system compound semiconductor (166 application physics, 60 volumes, No. 2, p163-p 1991). The luminescence wavelength of Light Emitting Diode which has the gallium-nitride system compound semiconductor of pn junction according to it is mainly near 430nm, and has the luminescence peak also in the ultraviolet region near 370 morenm. The wavelength is the shortest wavelength in the above-mentioned semiconductor material. However, since the Light Emitting Diode has the near luminescent color purple as luminescence wavelength shows, it has the fault that visibility is bad.

[0006] It is in this invention having been made in view of such a situation, and the place made into the purpose improving the visibility of Light Emitting Diode which has the light emitting device which a luminescence peak becomes from the gallium-nitride system compound semiconductor material near 430nm and near 370nm, and raising the brightness.

[0007]

[Means for Solving the Problem] this invention is Light Emitting Diode which it has a light emitting device on a stem, and the aforementioned light emitting device consists of a gallium-nitride system compound semiconductor expressed with general formula  $\text{GaXAl}_1\text{-XN}$  (however, it is  $0 \leq X \leq 1$ ) in the light emitting diode which comes to surround it by the resin mould, and the fluorescent dye which is further excited by luminescence of the aforementioned gallium-nitride system compound semiconductor in the aforementioned resin mould, and emits fluorescence, or a fluorescent pigment is added, and is characterized by the bird clapper.

[0008] Drawing 2 is one example which shows the structure of Light Emitting Diode of this invention. The blue light emitting device which, as for 11, comes to carry out the laminating of the GaAlN to n type and p type on silicon on sapphire, and 2 and 3 are the same with drawing 1, and a metal stem, a metal post, and 4 are resin moulds which surround a light emitting device. The rear face of a light emitting device 11 is the insulating substrate of sapphire, since an electrode cannot be taken out from a rear face, in order to connect n electrode of a GaAlN layer with the metal stem 2 electrically, a GaAlN layer is \*\*\*\*\*ed, the front face of n type layer is exposed, an ohmic electrode is attached, and the technique electrically connected by the gold streak is taken. Moreover, wire bond of other electrodes is carried out on the front face of p type layer by the gold streak lengthened from the metal post 3 like drawing 1. The fluorescent dye 5 which emits light in the wavelength which is furthermore excited by the resin mould 4 with the wavelength near 420-440nm, and has a luminescence peak in 480nm is added.

[0009]

[Effect of the Invention] Generally a fluorescent dye and a fluorescent pigment are excited by the light of short wavelength, and emit light in long wavelength light rather than excitation wavelength. Conversely, although there is also a fluorescent

pigment which is excited by the light of long wavelength and emits light in the light of short wavelength, energy efficiency is very bad and it does not emit light feebly. As described above, a gallium-nitride system compound semiconductor has the luminescence peak in a short wavelength side most in the semiconductor material used for Light Emitting Diode, and, moreover, has the luminescence peak also in the ultraviolet region. Therefore, when it is used as a material of a light emitting device, these fluorescent substances can be most suitably excited by adding a fluorescent dye and a fluorescent pigment to the resin mould which surrounds the light emitting device. Therefore, it can change the light of much wavelength according to the kind of a fluorescent dye and fluorescent pigment in saying the color correction of blue Light Emitting Diode. Furthermore, the light of short wavelength is changed into long wavelength, the fluorescent dye and fluorescent pigment which are added since energy efficiency is good can be managed with a minute amount, and it is very convenient also from the point of a fall of brightness.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The type section view showing the structure of the conventional Light Emitting Diode.

[Drawing 2] The type section view showing the structure of one example of Light Emitting Diode of this invention.

[Description of Notations]

11 ... Light emitting device 2 ... Metal stem

3 ... Metal post 4 ... Resin mould

5 ... Fluorescent dye.

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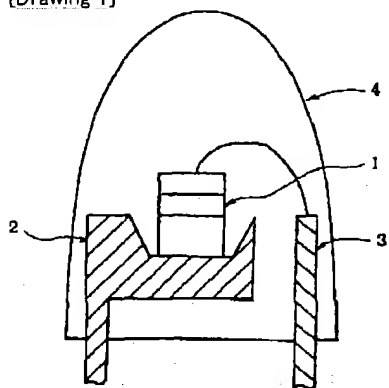
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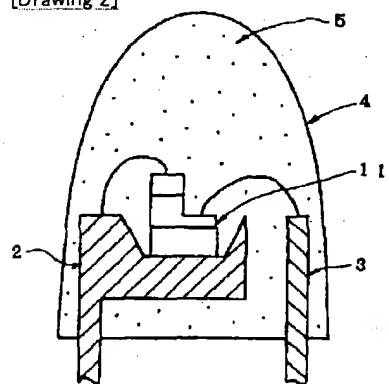
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DRAWINGS

[Drawing 1]



[Drawing 2]



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[Translation done.]